Burned Area Emergency Response
Terwilliger Fire
Willamette National Forest
Hydrology and Watershed Specialist Report
October 15, 2018

Rider Creek and Boone Creek watersheds and Terwilliger Hot Springs Area

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Fire and site description

This report summarizes the results from the hydrologic assessment of the Terwilliger Fire in the Cascades of Oregon, as part of the Burned Area Emergency Response (BAER). The Terwilliger Fire was human-caused and began on 19 August 2018, burning 11,463 acres as of October 12, 2018 (80% contained). The fire burned entirely within the boundaries of the Willamette National Forest and four 6th Field watersheds (Figure 2). The final soil burn severity was 2% high, 11% moderate, 65% low, and 22% Unburned (Table 1).

Table 1. Acres burned by Soil Burn Severity

Soil Burn Severity	Acres
High	173
Moderate	1,262
Low	7,468
Unburned	2,560
Total	11,463

The Terwilliger Fire took place in a region that experiences wet winters and dry summers (Figure 1). Precipitation throughout the burn area ranges from about 62 to 75 inches per year, with most of the precipitation occurring from October through May. In the lower elevations (<4,500 feet), precipitation is a mix of rain and snow. The higher elevations (>4,500 feet) has precipitation of mostly snow. The rain-on-snow zone, from about 2,000-4,500' in elevation, can produce very high peak flows during long-duration rain storms falling on a shallow snowpack.

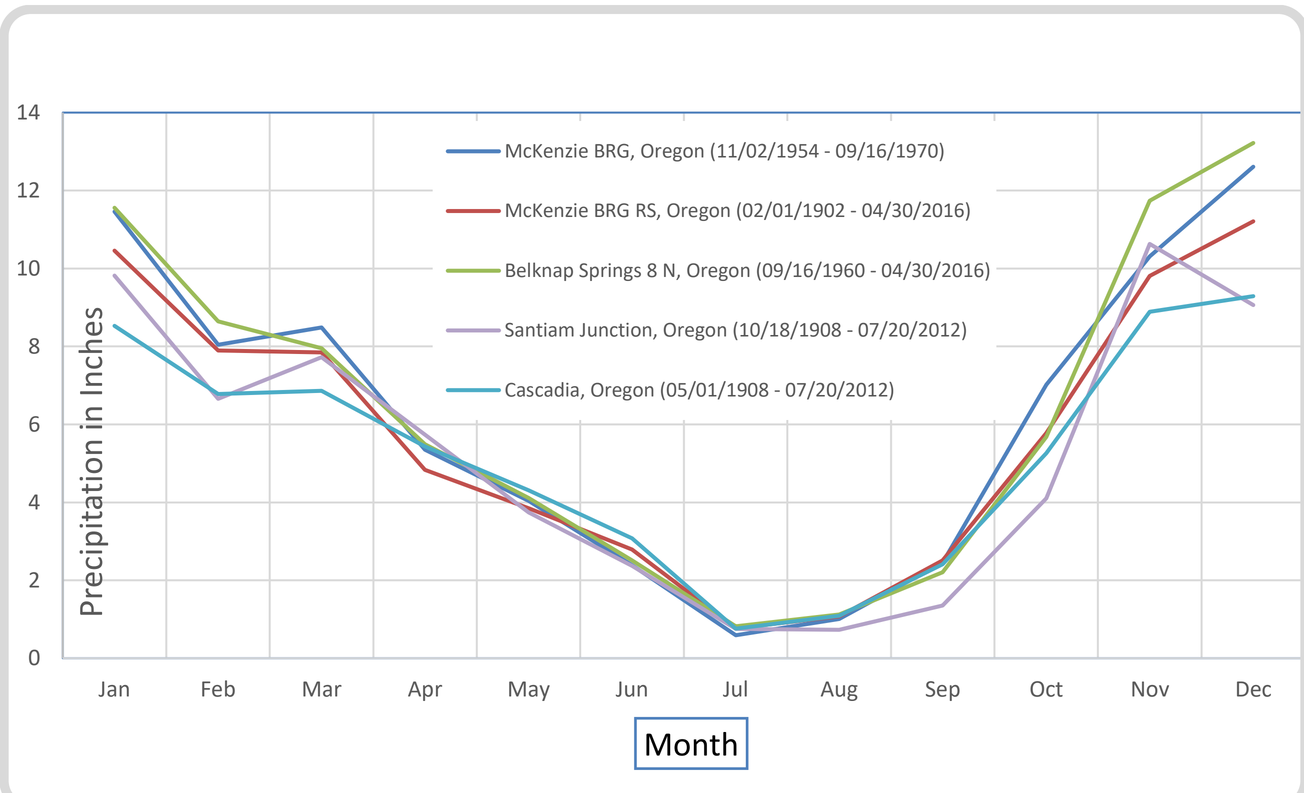


Figure 1. Average monthly precipitation at locations within and Around the burned area perimeter

Source: Western Regional Climate Center

Elevation within the burned area perimeter ranges between 1,692 ft. to 5,145 ft. Vegetation within the burned area was tree dominated (Table 2) and was comprised of a combination of different natural forest stands. Soil burn severity varied by pour-point watershed, with the unnamed creek near Sunnyside Campground experiencing the highest percentage of moderate and high soil burn severity (Appendix A). There are approximately 138 miles of streams within the burned area (Table 3).

Table 2. Vegetation Types

Vegetation Type	Area (acres)	% of Burned Area
Douglas-fir Zone	703	6.13%
Grand Fir Zone	75	0.65%
Mountain Hemlock Zone	16	0.14%
Pacific Silver Fir Zone	1,557	13.58%
Western Hemlock Zone	8,832	77.05%
White Fir Zone	259	2.26%
Undefined	21	0.18%
Total	11,463	100%

Table 3. Stream length by class

Stream Class	Length (miles)
Intermittent	104
Perennial	34
Total	138

This report details a hydrologic analysis conducted at two geographic scales; 6th Field watersheds at their outlet and at selected critical values (CV). These critical values typically include buildings, power plants, bridges, roads, trails, historical sites, cultural sites, culverts, and/or campgrounds (Appendix D). Note that there was no buildings needed to be modeled for the Terwilliger Fire.

Water Quality

Areas affected by the 2018 Terwilliger Fire drain portions of the Willamette River basin. Surface water bodies directly impacted by the fires include South Fork McKenzie River (Source to Cougar Reservoir) and mainstream McKenzie River (from the confluence with the South Fork downstream). Beneficial uses for the McKenzie River are Public Domestic Water Supply, Private Domestic Water Supply, Industrial Water Supply, Irrigation, Livestock Watering, Fish and Aquatic Life, Wildlife and Hunting, Fishing, Boating, Water Contact Recreation, Aesthetic Quality, and Hydro Power (Oregon, 2018). In addition, Tipsoo Creek is listed as impaired on the 303(d) list for Biological Criteria (Oregon, 2018). No Total Maximum Daily Loads (TMDL) currently exist for Tipsoo creek.

Wildfires primarily affect water quality through increased sedimentation. As a result, the primary water quality constituents or characteristics affected by this fire include color, sediment, settleable material, suspended material, and turbidity. Floods and debris flows can entrain large material, which can physically damage infrastructure associated with the beneficial utilization of water (e.g., water conveyance structures; hydropower structures; transportation networks). The loss of riparian shading and the sedimentation of channels by floods and debris flows may increase stream temperature. Fire-induced increases in mass wasting along with extensive tree mortality can result in increases in floating material – primarily in the form of large woody debris. Post-fire delivery of organic debris to stream channels can potentially decrease dissolved oxygen concentrations in streams. Fire-derived

ash inputs can increase pH, alkalinity, conductivity, and nutrient flux (e.g. ammonium, nitrate, phosphate, and potassium), although these changes are generally short lived.

The most noticeable effects on water quality will be possible increases in sediment and ash from the burned area into the South Fork McKenzie River, Cougar Reservoir, and other waterbodies in and downstream of the fire area. Based on historic precipitation patterns, frontal storms have a high probability of occurring in the weeks following the fire. The risk of flash flooding and erosional events will increase as a result of the fire, creating hazardous conditions within and downstream of the burned area. These hazardous conditions may be worsened in the case of a rain-on-snow event, where long-duration rainstorms falling on a shallow snowpack can produce very high peak flows and result in extensive flooding. This is not, however, an annual event. Within the Terwilliger Fire, the post-fire watershed threat should be reduced measurably after three to five years. Figure 2 represents all of the 6th field watersheds affected by the fire.

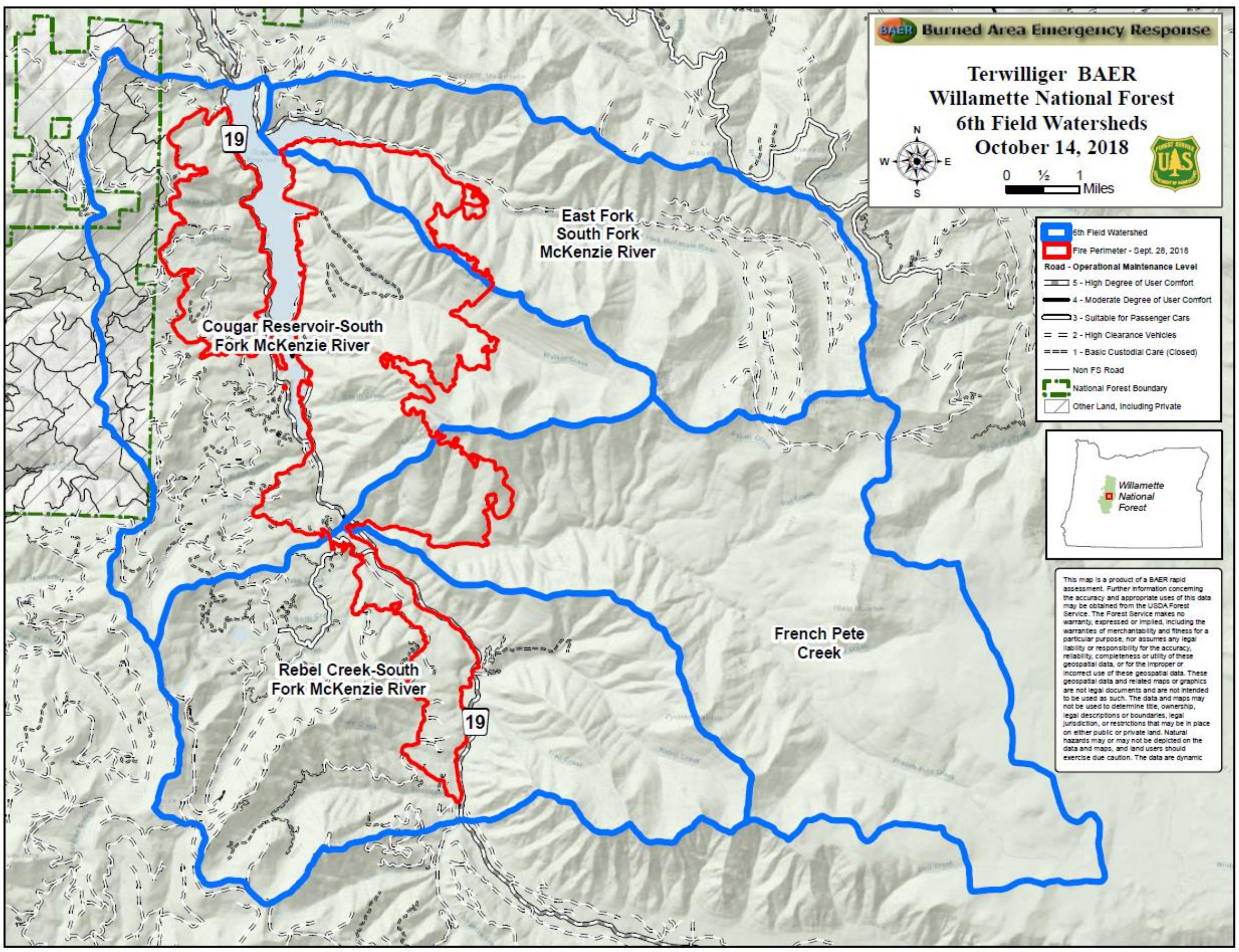


Figure 2. 6th Field watersheds affected by the Terwilliger Fire

Fire severity assessment

A Burned Area Reflectance Classification (BARC) image was acquired from the Forest Service Geospatial Service and Technology Center (GTAC). Based on comparisons with archived images, this image classifies the extent of the burned area into four categories: unburned, low severity burn, moderate severity burn, and high severity burn. BAER team member's ground truthed this image through field observations and observations made by helicopter for inaccessible areas. The BARC

image was found to have a relatively high degree of accuracy, but did require modifications to increase both spatial and severity accuracy.

Verification of soil burn severity included recording soil color, degree of organic material consumption, soil structure, fine root consumption and hydrophobicity. Hydrophobicity tests were conducted to determine the water repellency characteristics of affected soils. These tests were used to further evaluate the effect of the fire on post-fire hydrological response.

Anticipated watershed response

The primary watershed responses of the Terwilliger Fire are expected to include: 1) an initial flush of ash, 2) rill and gully erosion in drainages and on steep slopes within the burned area, and 3) floods with increased peak flows and sediment deposition. These responses are expected to be greatest in initial storm events, and will become less evident as vegetation is reestablished, providing ground cover, increasing surface roughness, and stabilizing and improving the infiltration capacity of the soils.

The estimated vegetative recovery for watersheds affected by the Terwilliger Fire is expected to recover within 3 to 5 years as observed in other Pacific Northwest watersheds. Flood potential will decrease as vegetation reestablishes, providing ground cover, increasing surface roughness, and stabilizing and improving the infiltration capacity of the soils. The risk or probability (R) that a certain return interval storm (T) will occur over different time periods (n) was calculated by the following equation (Chow et al. 1988): $R = 1 - (1 - \frac{1}{T})^n$

The design storm of 2 years has a 50% chance of occurring in any given year, and a 97% chance of occurring in the next five years. Conversely, there is a 3% chance that the 2 year storm event ***will not*** occur in the next 5 years **(**during the recovery period). The 2 year, 24 hour duration storms anticipated for these watersheds range between 3.5 inches and 4.2 inches (NOAA, 1973). Hydrologic design information is displayed in Table 6.

Before an adjusted design flow can be determined, pre-fire design flow must be calculated. This is the flow expected to occur in pre-fire conditions. This is the flow responsible for forming present day channel conditions and flows used to estimate proper performance of culverts and other drainage structures. Design flow estimates have been based on existing gage station information (Department of the Interior, 2018). These estimates assume pre-fire ground infiltration and ground cover conditions.

Adjusted design flow is calculated using the same relationships as design flow however runoff response is estimated by assuming an increased runoff commensurate with soil burn severity in terms of recurrence interval. This recurrence interval estimates the response of the newly burnt landscape to an average annual storm. The Terwilliger Fire is expected to respond to an average rainfall event, an event usually associated with the 1.5-year storm, differently for the low, moderate, and high severity burned areas. It is expected the landscape would respond as if the discharge were associated with a 1.75, 2, and 5-year event, respectively based on observations from other burned watersheds (Kaplan-Henry, 2004). The unburned lands within the fire would respond as the unburned lands outside the fire and would have a discharge associated with the 1.5 year return interval. The range in return interval is based on USGS gage station data in the immediate watershed area. Increases in discharge associated with predicted recurrence intervals are pro-rated across watersheds by soil burn severity to yield post-fire discharge or the adjusted design flow.

The fire has been analyzed at a watershed scale. Watersheds are various sizes and shapes and are dependent on the analysis of the desired outlet or pour point above a value at risk or area of concern. These sites may be within or downstream of the burned area. Size of watershed is dependent on the local flow patterns in addition to the need to evaluate a basin for Critical Values. Appendix A displays a map modeled 6th Field and Pourpoint Watersheds and the fire perimeter.

Initial erosion of ash and surface soil during the first storm events will reduce slope roughness by filling depressions above rocks, logs, and remaining vegetation. The ability of the burned slopes to detain water and sediment will be reduced accordingly. This will aid in the potential for floods and will increase the distance that eroded materials are transported. However, several factors favor a quick recovery in terms of normal hydrologic response of some hillslopes. The existence of fine roots in the low and moderate severity burn areas just below the surface will likely aid plant recovery, and suggests there still might be a seed source for natural vegetation recovery. The major concern for vegetative recovery and in turn hydrologic recovery is in the high severity burn areas.

Post-fire conditions have been assessed to determine how fire-induced changes to slope hydrology and soil conditions will impact the Critical Values. Key to this assessment is the burn severity mapping. Appendix B shows the number of acres affected by the different burn severities within the analysis watersheds.

Table 6. Hydrologic design factors

A. Estimated Vegetative Recovery Period	3-5 years
B. Design Chance of Success	80 %
C. Equivalent Design Recurrence Interval	2 years
D. Design Storm Duration	24 hours
E. Design Storm Magnitude	3.5 - 4.2 inches
F. Design Flow	40.63 cfs / mi^2
G. Estimated Reduction in Infiltration	12.5%
H. Adjusted Design Flow	41.16 cfs / mi^2

Appendix C shows predicted pre-fire and post-fire estimates of peak flood flows for the design storm. The increase in peak flows is most applicable during the first year of recovery, as hydrologic response will decrease in subsequent years. Predicted post-fire peak flows show an increase of about one to five times pre-fire values. The peak flow values highlight the post-fire effects on the Terwilliger Fire, with the most increase reflected in watersheds where burn severity is moderate and high and where the most susceptible soils are affected. The early precipitation events fill in available slope detention storage and create the rill and gully networks that are necessary to fully induce the expected increase in flood response from rainstorms.

The results of a peak flow analysis show that pre-fire area weighted flows were on average 40.63 cfs / mi^2 for a 2 year, 24 hour storm, and 41.16 cfs / mi^2 for post-fire flows. As previously mentioned, the post-fire flows could lead to plugged culverts, flow over road surfaces, rill and gully erosion of cut and fill slopes, erosion and deposition along road surfaces and relief ditches, loss of long-term soil productivity, and threats to human safety. Some sedimentation of the ephemeral channels is likely to occur at an accelerated rate until vegetation establishes itself and provides ground cover.

Flow relationships were developed using USGS gage stations. Gage stations were investigated to provide information on flow conditions following the 1.5, 1.75, 2.0, 5.0, 10, and 25 year events.

Gage data provided information on drainages within and near the fire area. The Table 7 displays gage data utilized to develop hydrologic relationships for discharge equations.

Table 7. Gage Station Data for Watersheds Affected or Near the Terwilliger Fire, 2018

Gage Station Location	Drainage Area in m^2	Discharge in Cubic Feet per Second					
		Q 1.5	Q 1.75	Q 2.0	Q 5.0	Q 10	Q 25
14158790 Smith River Above Smith River Reservoir, Near Belknap Springs	15.60	983	1056	1130	1624	2002	2757
14161500 Lookout Creek Near Blue River, Oregon	24.10	1340	1550	1760	2668	3357	5546
14161100 Blue River Below Tidbits Creek, Near Blue River, Oregon	45.80	3136	3470	3804	5508	7552	10464
14185700 Middle Santiam River Near Upper Soda, Oregon	74.60	4380	4572	4763	8150	12133	18400
14159200 South Fork McKenzie River Above Cougar Lake Near Rainbow, Oregon	160	4100	4715	5320	7805	8793	10542

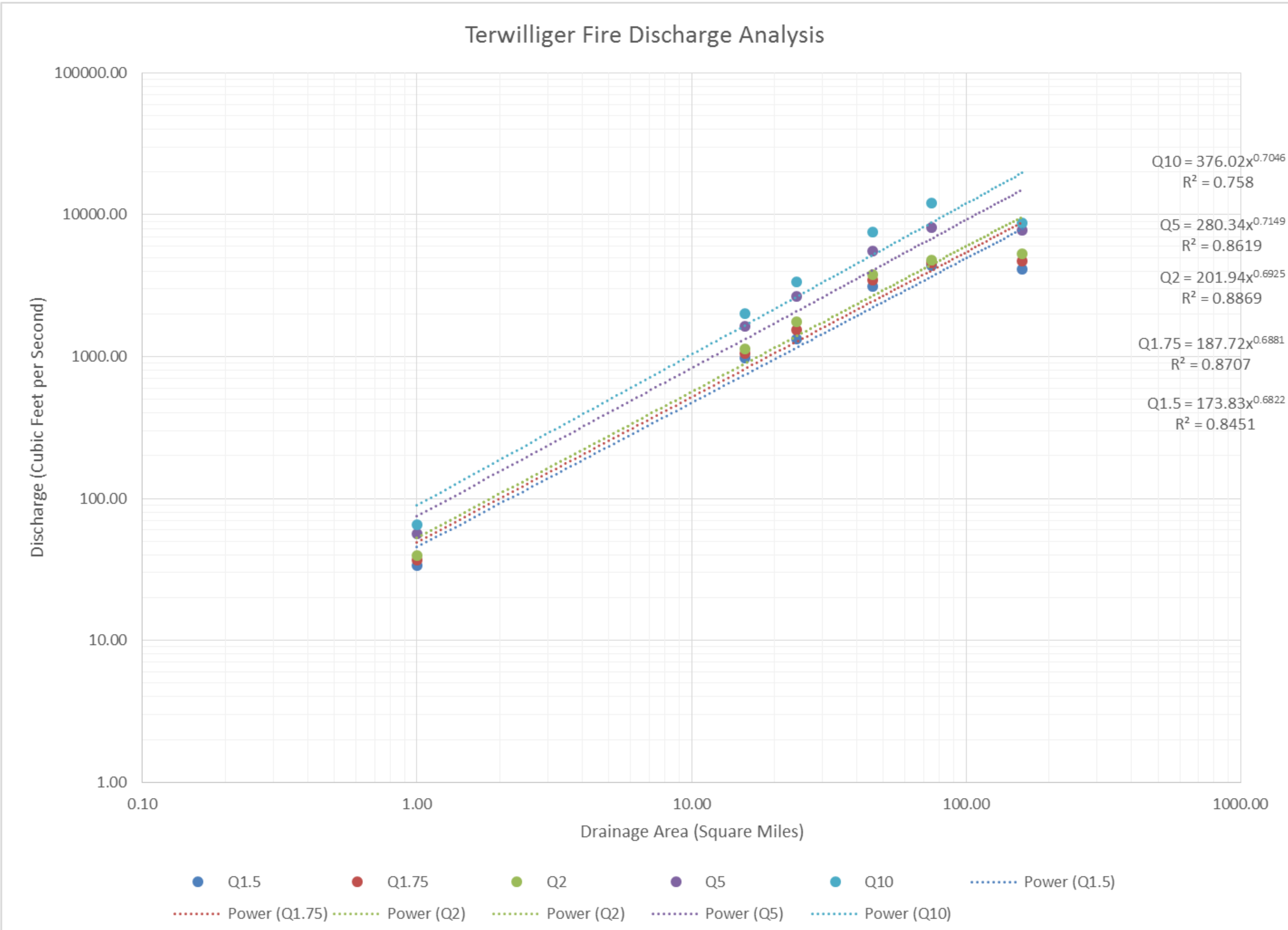
Gage station values were plotted in a log-log plot by recurrence interval using a linear interpolation for the bankfull discharge. Although the 10 and 25-year recurrence intervals are not used in this analysis they have been provided.

Figure 3 displays discharge relationships and recurrence intervals for the watersheds affected by the Terwilliger fire. The following equations were applied to affected watersheds to yield discharge in cubic feet per second and divided by the size of the watershed to give a discharge in cubic feet per second per square mile for the 1.5, 1.75, 2, 5.0, and 10.0 year discharge values by watershed size. These values were then multiplied by the area of the watershed by soil burn severity which includes unburned lands. These values were then added together to provide a predicted post-fire discharge value by each watershed. Pre-fire discharge was calculated using the bankfull discharge equation (1.5 year discharge equation). Estimates of pre-fire conditions may be determined from **Figure 3**, Discharge Relationship for Terwilliger Fire Area by Drainage Area and Recurrence Interval.

Appendix C provides values utilized to derive estimates of predicted post burn discharges and a display of the predicted increases in both cubic feet per second and cubic feet per second per square mile for the watersheds affected by the fire.

Figure 4 provide a visual display of pre and post-fire discharges for all evaluated pourpoint watersheds to illustrate the watersheds that are expected to have a significant increase in water yields.

Figure 3: Terwilliger Fire Discharge Analysis



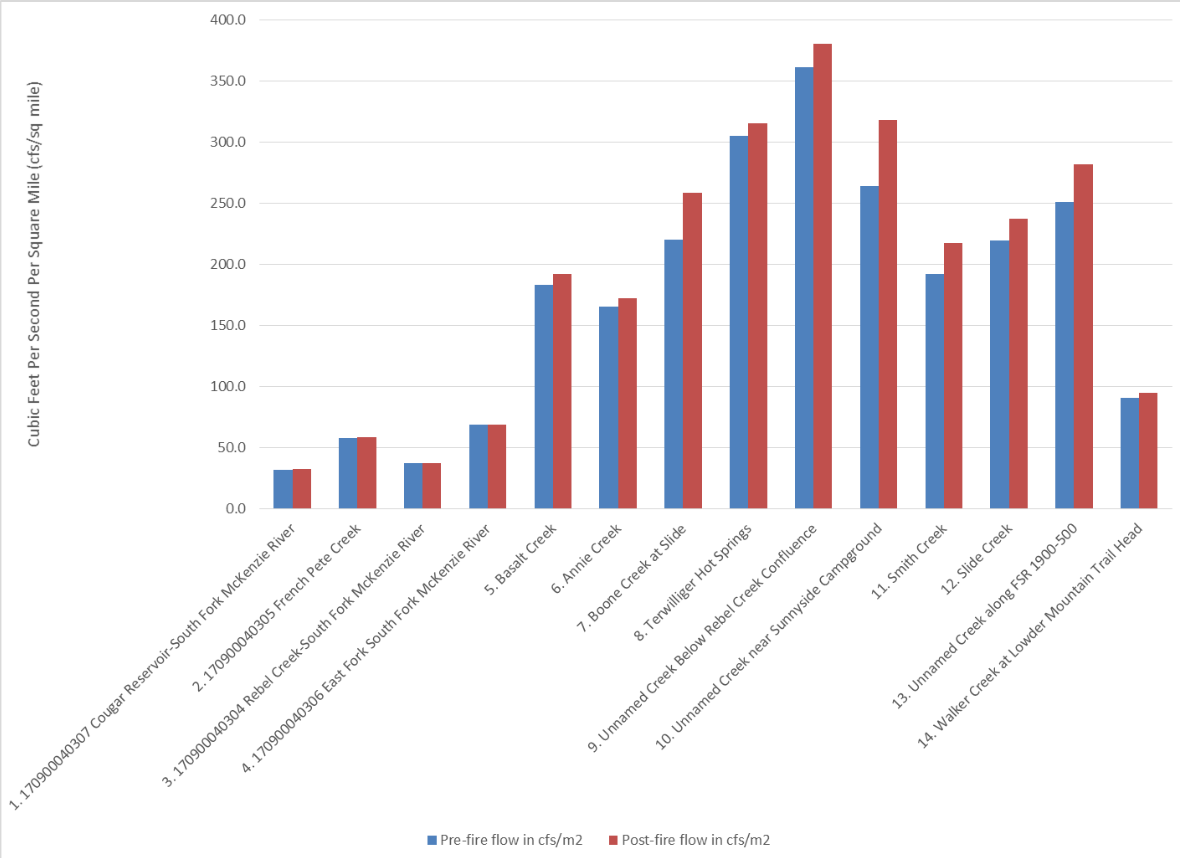


Figure 4. Pre-fire and post-fire streamflow per square mile in 6th Field watersheds and modeled pourpoint watersheds

Implications of post-fire runoff

The objective of this analysis is to predict post-fire runoff with the goal of mitigating risk to life, property, and natural and cultural resources. After identifying potential CVs, the magnitude of this risk was systematically evaluated. The risk matrix shown in Table 8 was utilized to identify values in need of mitigation efforts.

Table 8. Risk assessment matrix

Probability of Damage or Loss	Magnitude of Consequences		
	Major	Moderate	Minor
	Risk		
Very likely	Very High	Very High	Low
Likely	Very High	High	Low
Possible	High	Intermediate	Low
Unlikely	Intermediate	Low	Very Low

The probability of damage or loss within one to three years is classified into four categories: unlikely occurrence (<10%); possible occurrence (>10% to <50%); likely occurrence (>50% to

<90%); and very likely or nearly certain occurrence (>90%). This information is combined with an assessment of the magnitude of the consequences. These are classified as major, with implications for loss of life or injury to humans, substantial property damage, irreversible damage to critical natural or cultural resources; moderate, indicating injury or illness to humans, moderate property damage, damage to critical natural or cultural resources resulting in considerable or long term effects; or minor, with property damage limited in economic value and/or to a few investments, damage to natural or cultural resources resulting in minimal, recoverable or localized effects.

Localized treatment for individual CVs vary. Specific recommended treatments to mitigate altered flows could include wattles, stream channel cleanout, stream channel armoring, rolling dips, overflow structures, low-water stream crossings, culvert modification, catchment-basin cleanout, storm inspections and response, trail stabilization, road closures, mitigation for threatened and endangered aquatic species, warning signage, jersey barriers, sandbags, securing sources of hazardous materials, and flood warning systems. See Appendix D for identified CVs and their recommended treatment.

Conclusions

As a result of the Terwilliger Fire minor increases in runoff are expected in pourpoint watersheds. These increases are result of the low percentages of high and moderate soil burn severity within these watersheds. The 6th Field watershed, Cougar Reservoir-South Fork McKenzie River shows increases in water yield of 1.01 times greater respectively than pre fire conditions. The pourpoint watersheds, Unnamed Creek near Sunnyside Campground and Boone Creek at Slide, show increases in water yield of 1.20 and 1.18 times greater respectively than pre-fire conditions. This increase is for the Q1.5 storm or a discharge that has a 75% chance of occurring over the course of the year. Depending on location of the Critical Values from the Terwilliger Fire; these values may be affected as a result of the burn under design storm conditions. Details on Critical Values and treatments may be found in the 2500-8 BAER Report for the Terwilliger Fire.

References

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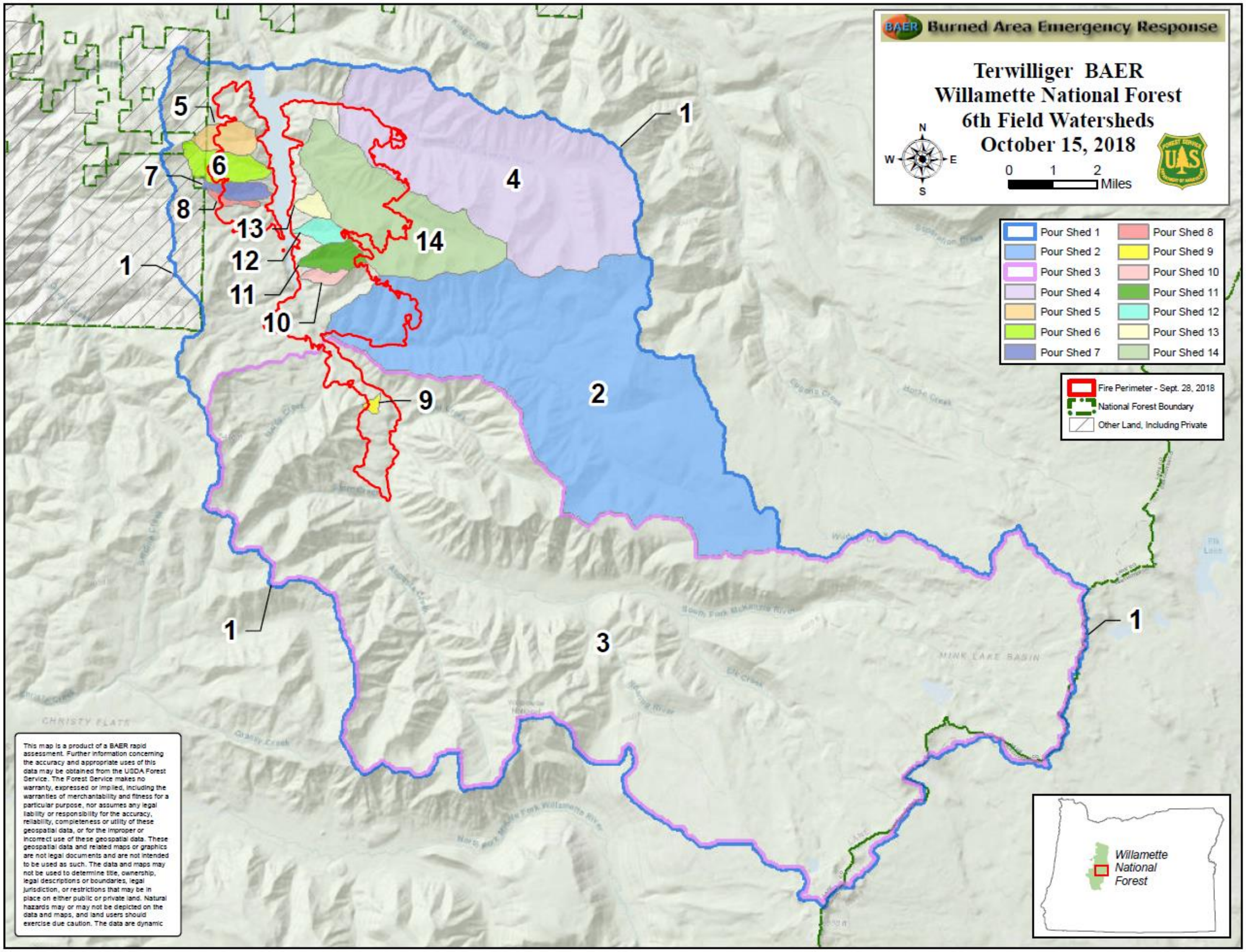
Kaplan-Henry, Terry. October 2004. McNally Postfire Discharge and the Relationship of Sierra Nevada-Wide Flood Frequency Curves and Local Kern River Discharge Curves. Advancing the Fundamental Sciences; Proceedings of the Forest Service National Earth Sciences Conference, San Diego, 18-22 October 2004.

NOAA. Precipitation-Frequency Atlas of the Western United States. 1973. Volume X-Oregon.

List of Appendices

APPENDIX A: Pour Point Watershed Map for Terwilliger Fire



APPENDIX B: 6th field watersheds and pourpoint watersheds affected by the Terwilliger Fire. Percent of watersheds burned are reported parentheses.

Watershed	Watershed acres	High Acres	Moderate Acres	Low Acres	Unburned Acres
1. 170900040307 Cougar Reservoir-South Fork McKenzie River	132,739	173 (0.1%)	1,263 (1.0%)	7,468 (5.6%)	123,835 (93.3%)
2. 170900040305 French Pete Creek	20,149	0 (0%)	27 (0.1%)	798 (4.0%)	19,324 (95.9%)
3. 170900040304 Rebel Creek-South Fork McKenzie River	80,063	0 (0%)	75 (0.1%)	935 (1.2%)	79,052 (98.7%)
4. 170900040306 East Fork South Fork McKenzie River	11,750	0 (0%)	8 (0.1%)	372 (3.2%)	11,368 (96.8%)
5. Basalt Creek	541	0 (0%)	24 (4.5%)	277 (51.3%)	239 (44.2%)
6. Annie Creek	748	2 (0.3%)	34 (4.6%)	298 (39.8%)	413 (55.3%)
7. Boone Creek at Slide	305	53 (17.4%)	117 (38.2%)	71 (23.2%)	64 (21.1%)
8. Terwilliger Hot Springs	109	0 (0%)	5 (4.4%)	43 (39.6%)	61 (56.0%)
9. Unnamed Creek Below Rebel Creek Confluence	64	0 (0%)	5 (7.2%)	42 (66.5%)	17 (26.3%)
10. Unnamed Creek near Sunnyside Campground	171	38(22.0%)	67 (39.2%)	65 (38.2%)	1 (0.6%)
11. Smith Creek	464	33 (7.2%)	163 (35.0%)	196 (42.4%)	71 (15.4%)
12. Slide Creek	308	5 (1.6%)	54 (17.7%)	190 (61.8%)	58 (19.0%)
13. Unnamed Creek along FSR 1900-500	200	9 (4.5%)	79 (39.3%)	102 (50.8%)	11 (5.3%)
14. Walker Creek at Lowder Mountain Trail Head	4,940	22 (0.5%)	252 (5.1%)	1,914 (38.7%)	2,751 (55.7%)

Table B1: Burn Severity of 6th Field Watersheds and Modeled Pourpoint Watersheds Affected by the Terwilliger Fire

APPENDIX C: Pre-fire & post-fire flow numbers using 2 year return interval with 24 hour intensity

Watershed	Watershed acres	Pre Fire Discharge	Post Fire Discharge	Times Increase
1. 170900040307 Cougar Reservoir-SF McKenzie R	132,739	6616.96	6681.82	1.01
2. 170900040305 French Pete Creek	20,149	1828.56	1836.47	1.00
3. 170900040304 Rebel Creek-SF McKenzie River	80,063	4686.74	4693.82	1.00
4. 170900040306 East Fork South Fork McKenzie River	11,750	1265.66	1269.82	1.00
5. Basalt Creek	541	154.94	162.32	1.05
6. Annie Creek	748	193.31	201.38	1.04
7. Boone Creek at Slide	305	104.81	123.23	1.18
8. Terwilliger Hot Springs	109	51.96	53.69	1.03
9. Unnamed Creek Below Rebel Creek Confluence	64	36.08	38.00	1.05
10. Unnamed Creek near Sunnyside Campground	171	70.75	85.22	1.20
11. Smith Creek	464	139.54	157.83	1.13
12. Slide Creek	308	105.49	114.20	1.08
13. Unnamed Creek along FSR 1900-500	200	78.65	88.09	1.12
14. Walker Creek at Lowder Mountain Trail Head	4,940	700.79	735.02	1.05

Table C1: Change in Discharge for 6th Field Watersheds and Modeled Pourpoint Watersheds Affected by the Terwilliger Fire

Appendix D: Critical Values

Terwilliger BAER

Willamette National Forest – McKenzie River Ranger District

This appendix includes Critical Values (CVs) that were identified and analyzed by the Terwilliger BAER assessment. The objective of this analysis is to predict post-fire effects with the goal of mitigating risk to life, property, and natural and cultural resources. After identifying potential CVs, the magnitude of this risk was systematically evaluated. The risk matrix shown in Table D1 was utilized to identify values in need of mitigation efforts.

Table D1. Risk assessment matrix

Probability of Damage or Loss	Magnitude of Consequences		
	Major	Moderate	Minor
	Risk		
Very likely	Very High	Very High	Low
Likely	Very High	High	Low
Possible	High	Intermediate	Low
Unlikely	Intermediate	Low	Very Low

The probability of damage or loss within one to three years is classified into four categories: unlikely occurrence (<10%); possible occurrence (>10% to <50%); likely occurrence (>50% to < 90%); and very likely or nearly certain occurrence (>90%). This information is combined with an assessment of the magnitude of the consequences. These are classified as major, with implications for loss of life or injury to humans, substantial property damage, irreversible damage to critical natural or cultural resources; moderate, indicating injury or illness to humans, moderate property damage, damage to critical natural or cultural resources resulting in considerable or long term effects; or minor, with property damage limited in economic value and/or to few investments, damage to natural or cultural resources resulting in minimal, recoverable or localized effects.

Table D3 includes all Critical Values identified for the Terwilliger Fire. Tables also include information on risk assessment, proposed treatments, and other notes. CVs were highlighted to identify that a treatment was proposed. Table D2 shows the color scheme legend that was used (yellow for intermediate risk, red for high risk, and dark red for very high risk). For more information on CVs, proposed treatments, and the CV map refer to the 2500-8 for the Terwilliger Fire.

Table D2: Color Scheme Legend	
	Risk Level
	Very High
	High
	Intermediate (Where Treatments Are Recommended)

Table D3: Critical Values Identified for the Terwilliger Fire

Value (Life/Property/ Resources)	Critical Value	Probability of Damage or Loss	Magnitude of Consequences	Risk	Treatment
NFS Roads, Bridges, and Culverts					
Property	FSR 1900	Likely	Moderate	High	Storm Inspection and Response (RT2)
Life	FSR 1900	Possible	Major	High	Road Hazard Signs (P1a)
Property	FSR 1900-500	Likely	Moderate	High	Storm Inspection and Response (RT2)
Life	FSR 1985-115	Possible	Major	High	P10 (Closure)
Property	FSR 1985-115	Likely	Moderate	High	Storm Inspection and Response (RT2)
NFS Hot Springs, Trails, and Recreational Boating					
Life	Terwilliger Hot Springs	Very Likely	Moderate	Very High	Hazardous Materials (P5)
Life	Terwilliger Hot Springs	Possible	Major	High	Site Closure (P10)
Property	Terwilliger Hot Springs	Possible	Major	High	Infrastructure Protection (P6)
Life	3319 Rider Creek Trail	Possible	Major	High	Trail/Recreation Hazard Signs (P1b)
Property	3319 Rider Creek Trail	Very Likely	Moderate	Very High	Trail Infrastructure Protection (RT14)
Life	3308 East Fork Trail	Possible	Major	High	Trail/Recreation Hazard Signs (P1b)
Life	3329 Lowder Mountain Trail	Possible	Major	High	Trail/Recreation Hazard Signs (P1b)
Life	3311 French Pete Creek Trail	Possible	Major	High	Trail/Recreation Hazard Signs (P1b)
Property	3311 French Pete Creek Trail	Very Likely	Moderate	Very High	Trail Infrastructure Protection (RT14)
Life	South Fork McKenzie River	Possible	Major	High	Trail/Recreation Hazard Signs (P1b)
Water Used for Hydropower, Municipal Water Supply, and Waters with Special Federal or State Designations on NFS lands					
Resources	South Fork McKenzie River above Cougar Reservoir (Wild and Scenic Study River)	Unlikely	Minor	Very Low	Agency Coordination (M5)
Resources	South Fork McKenzie River below Cougar Reservoir (Municipal Water Supply)	Unlikely	Moderate	Low	Agency Coordination (M5)
Resources	South Fork McKenzie River and Cougar Reservoir (Water Used for Hydropower)	Possible	Minor	Low	Agency Coordination (M5)

Value (Life/Property/ Resources)	Critical Value	Probability of Damage or Loss	Magnitude of Consequences	Risk	Treatment
Soil Productivity					
Resources	Soil Productivity	Possible	Moderate	Intermediate	None
ESA-Threatened Fish					
Resources	Bull Trout	Unlikely	Minor	Very Low	None
Resources	Spring Chinook Salmon	Unlikely	Moderate	Low	None
Resources	Bull Trout Critical Habitat	Unlikely	Minor	Very Low	None
Resources	Spring Chinook Salmon Critical Habitat	Unlikely	Moderate	Low	None
ESA-Endangered Wildlife					
Resources	Quality and quantity of remaining Northern Spotted Owl Critical Habitat and suitable habitat	Likely	Minor	Low	None
Heritage Resources					
Resources	Heritage Resources	Unlikely	Major	Intermediate	None
Botanical Resources					
Resources	Native Plant Communities	Very Likely	Major	Very High	Invasive EDRR (L1a, L1b)